

Original article:

Study of variations in resting heart rate and peak expiratory flow rate in different trimesters of pregnancy

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Abstract:

Background: During pregnancy various changes occurs in cardiopulmonary functions in healthy pregnant woman. Sometime these changes may be beneficial for healthy pregnant woman or sometimes these changes may create health problems. But most important thing is in healthy pregnant woman the normal values for these parameters may altered as compare to healthy non-pregnant woman and must be thoroughly evaluated before therapeutic intervention.

Materials and Methods: This case control observational study was carried out in the Department of Physiology in collaboration with Obstetrics and Gynecology Department at Rural Medical College Loni. The total nine hundred forty women aged from 20 to 40 years without any recent history of cardiopulmonary diseases were selected. Among total participants seven hundred five were pregnant in group and two hundred thirty-five were in non-pregnant group. Case group was further divided in three trimesters 1st, 2nd, and 3rd trimester with two hundred thirty-five subjects in each trimester. Resting hart rate was studied on “CANWIN- Cardiac Autonomic Neuropathy Analyzer”, and Peak Expiratory flow rate was studied on Spirova SP-1.

Results: Significant increase in R H R ($p < 0.05$) & highly significant decreased P E F R observed in pregnant women as compare to non-pregnant women.

Conclusion: The study showed significant increase in RHR & PEFR in the healthy pregnant women as compared to non- pregnant women from rural population of India. Study of parasympathetic functions must be done to predict any pre-existing autonomic dysfunction during pregnancy.

Key words: Resting Heart rate, Peak Expiratory Flow Rate, Spirova SP-1, pregnant women

INTRODUCTION

The decline in systemic vascular resistance may fall the workload of the heart, leading to decrease sympathetic modulation in the first trimester of pregnancy.¹ Maternal physiologic adaptations during pregnancy take place in multiple systems long before they are

functionally necessary. By the seventh week, significant changes were observed in body compositions and cardiopulmonary and metabolic functions.² The heart rate is consistent with the adaptation of the maternal heart in pregnancy. He observed a rise in heart rate starting between two to five weeks and

continuing well into the third trimester.³ An increase in heart rate is seen as early as the 15th week of gestation. Since pregnancy is associated with a large increase in blood volume due to a marked increase in plasma volume.

The increase in blood volume increases the cardiac output. The marked augmentation of cardiac output in pregnancy results from asynchronous increase in both heart rate and stroke volume. The study also states that the parasympathetic deactivation towards term is likely to contribute to increased heart rate and cardiac output at rest in pregnancy.⁴ The decreased parasympathetic and increased sympathetic tone at rest in mid-pregnancy to the increased heart rate in pregnancy.⁵ It was noted that cardiac flow was increased due to increased systolic flow, cardiac frequency, blood volume, plasma volume and the red cell mass. But the increase of cerebral blood flow is limited by the cerebral auto-regulation.⁶

The pulmonary changes are more marked in the presence of over distention of gravid uterus like hydramnios & multiple pregnancy.⁷ The decrease in pulmonary function may be due to a decline in alveolar PCO₂ (caused by hyperventilation) which acts as bronchoconstrictor.⁸ The first trimester can be to morning sickness, lack of nutrition whereas in second and third trimester it may be due to mechanical pressure of enlarging gravid uterus, Elevation of the diaphragm by 4cm and restrictive movements of lungs. It was also found that the hampering forceful expiration due to decrease alveolar PCO₂ on the bronchial smooth muscles. PEFr was found to be significantly decreased in first trimester as compared to second and third trimester.⁹

The lower ribs were an increase in sub costal angle and transverse diameter of the chest.¹⁰ They showed significant change in I, II & III trimesters of normal pregnant women. Highly significant decline in PEFr in all the trimesters of pregnancy as compared to control was observed.¹¹ Observed in the study decline

in PEFr during pregnancy occurs suggestively due to lesser force of contraction of main expiratory muscles like anterior abdominal muscles and internal intercostal muscles. In the first trimester there was anemia due to more sickness and lack of supplementation of iron and calcium as compared to second and third trimester in which the subject was taking the iron and calcium supplementation.¹²

MATERIALS & METHODS

This was a case control observational study was carried out in the Department of Physiology in collaboration with Obstetrics and Gynecology Department at Rural Medical College Loni from India.

The study was carried out after the approval from institutional ethics committee (PMT/PIMS/RC/2013/226)

The total Nine hundred forty women aged from 20 to 40 years without any recent history of cardio- respiratory diseases were selected. Among total participants seven hundred five were pregnant in case group and two hundred thirty-five were non-pregnant in control group. Case group was further divided in three trimesters 1st trimester, 2nd trimester, and 3rd trimester with two hundred thirty-five subjects in each trimester.

Inclusion Criteria:

- Age group 20 to 40 years.
- Pregnant women visiting the hospital for routine checkup.
- Free from any systemic illness which can affects cardiopulmonary function.
- Able to complete the tests for cardiopulmonary function test.

Exclusion Criteria:

- H/O of any cardiopulmonary disorders
- H/O of addiction to tobacco, mishri, alcohol etc.
- H/O any type of medication which can affect cardiopulmonary function test.

A written consent was obtained from all the willing participants (pregnant and non-pregnant) before the start of the study. Data comprising of demographic parameters like

Name, Age (Years), Height (cm), Weight (Kg) and Family/ Medical/ Menstrual history were obtained and recorded from all pregnant and non-pregnant participant. Special emphasis was given for findings suggestive of cardiopulmonary functions. All measurements were performed 60 minutes under standardized resting condition between 09:00 to 12:00 hours as described by Voss et al.¹³ to avoid the effects of circadian rhythms on heart rate and in a quiet room.

Resting heart rate (RHR) was measured by automatic “Cardiac Autonomic Neuropathy Analyzer” (CANWIN).

Procedure: The participant was relaxed, lying down comfortably and the heart rate was recorded for one minute in lead II of ECG.¹⁴

RHR is 60 to 90 beat/min. (Normal)

Peak expiratory flow rate (PEFR) “Spirovit – SP-1” (Schiller) (Schiller International Ltd) was used to perform teste.

Procedure was explained to participant. The participant was asked to blow the air into the mouthpiece for recording of PEFR. Then the parameters PEFR were recorded in the participant. After recording the parameters, the records were saved in the machine.

PFER = 350 to 400 lit. /min.

Statistical analyses were done by one-way ANOVA (Kruskal-Wallis Test) between the study groups control and cases. The p value < 0.05 was taken as significant, p value < 0.001 was taken as significant and p value >0.05 was taken as non-significant.

RESULTS

Parameters	Non-pregnant	1st trimester	2nd trimester	3rd trimester
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (year)	22.81 ± 3.37	22.37 ± 3.65	21.78 ± 2.33	22.10 ± 2.69
Height (cm)	154.99 ± 4.81	154.99 ± 4.82	155.41 ± 5.05	155.26 ± 4.95
Weight (Kg)	49.06 ± 5.66	48.32 ± 5.60	51.32 ± 6.64*	57.06 ± 5.62*
Weeks of Gestations	----	8.85 ± 1.77	20.45 ± 3.87	33.94 ± 2.99

Table no. 1 Shows comparison of anthropometric parameters results between non-pregnant (controls) and 1st 2nd and 3rd trimesters of pregnancy. There was statistical no-significant (P>0.05) difference in the parameters age, and height, but weight was statistically significant (P < 0.05*) during 2nd and 3rd trimester when compared with non-pregnant (control) by One Way ANOVA Test.

Parameters	Non-pregnant	1st trimester	2nd trimester	3rd trimester
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Resting Heart Rate /minute	77.09 ± 6.24	82.77 ± 11.01	88.56 ± 9.84	95.06 ± 16.13
Peak expiratory flow rate (lit/min)	360.18 ± 52.45	339.33 ± 49.85	294.73 ± 41.45	236.4 ± 45.98

Result showed Statistically significant difference (P<0.05) vs non-pregnant in RHR and highly significant difference (P<0.001) vs non-pregnant in PEFR.

Table no. 2 comparison of cardiopulmonary function tests in results between non-pregnant (controls) and 1st 2nd and 3rd trimesters of pregnancy. There was statistically significant (P < 0.05) difference in the RHR, and PEFR was highly statistically significant (P < 0.001) during 2nd and 3rd trimester when compared with non-pregnant (control) by One Way ANOVA Test.

Table: 3 multiple comparison for analysis cardiopulmonary function test result between different group of study population and control

	Resting heart rate				Peak expiratory flow rate		
	Control	1st trimester	2nd trimester		Control	1st trimester	2nd trimester
1st trimester	P<0.05			1st trimester	P<0.001		
2nd trimester	P<0.05	P<0.05		2nd trimester	P<0.001	P<0.001	
3rd trimester	P<0.05	P<0.05	P<0.05	3rd trimester	P<0.001	P<0.001	P<0.001

Statistically significant difference P<0.05 in Resting heart rate as well as with one another, highly significant difference (P<0.001) in Peak expiratory flow rate as well as with one another.

DISCUSSION

Resting heart rate response was evaluated in all the pregnant and non-pregnant (control). The mean and SD of RHR in control, 1st, 2nd and 3rd trimesters were 77.09 ±6.24, 82.77±11.01, 88.56 ±9.84 and 95.06 ±16.13 respectively (table 2). Resting heart rate showed a significant P>0.05 increase in 1st, 2nd and 3rd trimester when compared to non-pregnant(control). Heart rate increased by approximately 15% in the 5th week, and its increase after 8th week to a maximum of approximately 85-90 beats per minute.^{2,15} The increase in heart rate in 3rd trimester is attributed to significantly decrease in vagal baroreflex in healthy women in 3rd trimester. Heart rate variability and baroreflex sensitivity are reduced in pregnancy in comparison with non-pregnant state.^{2,16,17,18}

Similar finding was recorded in study of adaptation of the maternal heart in pregnancy whereby a rise in heart rate was revealed starting between two to five weeks and continuing well into the third trimester.³ Heiskanen proposed that the parasympathetic deactivation towards term is likely to contribute to increased heart rate and cardiac

output at rest in pregnancy.⁴ Shapiro LM et al. observed from a hemodynamic standpoint, the most important change that occurs in the maternal circulation during pregnancy is an increase of cardiac output as a result of increases in heart rate and stroke volume. The fact that pregnancy induced increase in heart rate was diminished in the diabetic women suggests impaired adaptation of the cardiovascular system to pregnancy. Our observations cannot provide an explanation for this. However, early autonomic dysfunction may be involved, considering the fundamental role of the autonomic nervous system in regulation of heart rate.¹⁵

The findings of the present study are similar to the earlier studies. An increased heart rate during pregnancy is mediated by the lower level of parasympathetic/vagal discharge.²⁰ Our results showed a similar significant rise in all trimesters. The similar changes in HR were obtained when studied in left lateral position.²¹ Ekholm et al. observed from the initial biphasic heart rate response to standing is reflected in the maximum/minimum ratio and is significant in the mid-term pregnancy. The instantaneous increase in heart rate was similar in 2nd trimester and 3rd trimester of pregnancy.²²

Thomas Walther found an increase in heart rate in pregnant women during the second half of pregnancy.²³ Robson reported increase in heart rate synchronously by 10-15 beats per minute in pregnancy, so the cardiac output begins to rise.²⁴ Ekholm EM, & Erkkola RU. et al observed that Pregnancy imposes a good deal of functional strain on the cardiovascular system and many important and reversible changes take place in the cardiovascular dynamics of the body during normal pregnancy.²⁵

The result obtained when the PEFR was evaluated in pregnant and non-pregnant (control) is discussed below. Mean and SD of decrease in PEFR in control, 1st, 2nd and 3rd trimesters are 360.18±52.45, 339.33±49.85, 294.73±41.45& 236.4±45.98 respectively

(table 2). Decrease in PEFR was significant in 1st, 2nd and 3rd trimester pregnancy compared to non-pregnant. However, there was significant decrease of PEFR in 1st trimester compared to 2nd and 3rd trimester pregnancy.

Our study showed significant decrease in PEFR in all trimesters as compared to control. As per studies on PEFR by Neeraj & workers, there was decrease in PEFR in third trimester & decrease was attributable to the decline in alveolar PCO₂ which acts as bronchoconstrictor. Also the decrease in PEFR could be due to lesser force of contraction of main expiratory muscles like the anterior abdominal wall muscles & internal intercostals muscles.⁸ A study by Leo R. Brancazio & workers showed that PEFR does not change with pregnancy. Not only are the absolute mean peak expiratory flow rates similar at all four times, but the mean normalized peak expiratory flow rates in all groups are close to unity.¹⁰ Some studies suggest, inadequate nutrition due to morning sickness, altered eating habits associated with advancing gestation that resulted in muscular weakness & the lesser force of contraction of main expiratory muscle.¹²

A work on PEFR by Sunyal DK et al there was decrease in PEFR in all trimesters of pregnancy which is significant in 2nd & 3rd trimesters of pregnancy. The cause for the decrease was more likely due to lesser force of contraction of the expiratory muscles like anterior abdominal muscles & internal intercostals muscles in this state.¹⁷ Moreover, progressively reduced value of PEFR in three trimesters of pregnancy may be attributed to the mechanical effects of enlarged gravid uterus reducing vertical dimension by limiting movement of diaphragm. In addition, some degree of obstruction to the expiratory flow, especially late in pregnancy also contributes.²⁶

CONCLUSION

From the present study, we may conclude, pregnancy was associated with statistically significantly increased resting heart rate in 1st, 2nd and 3rd trimester of pregnancy as compared

to non-pregnant (control). The RHR showed statistically significant difference when the various trimester groups were compared with one another. These observed changes possibly reflect decreased vagal baroreflex control of the heart.

The PEFR was highly significant decreased in all trimesters of pregnancy as compared with non-pregnant (control) as well as with one another. Pulmonary functions test decreased because of upward displacement of diaphragm, reduced strength of expiratory muscles and mechanical effect of growing uterus.

PUBLIC HEALTH IMPORTANCE:

- Pregnant women should visit the ANC more frequently during the 3rd trimester of pregnancy, when there is high fluctuations in cardio-pulmonary functions.
- So, to conclude this study will go a long way in decreasing the maternal mortality in this rural population.

LIMITATIONS OF THE STUDY

- Non-Probability sampling method adopted for selection of participants
- Weight & BMI matching not done
- No baseline data taken
- All parity participants were included (1st, 2nd & 3rd trimester)

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